

WHAT IS CLAIMED IS:

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1. An image distortion correction apparatus comprising:

a circumscribed rectangle extraction unit
which extracts a circumscribed rectangle for each
10 character in a distorted image scanned by an image
reading unit to read an original placed on a
reference plane;

a character string extraction unit which
extracts character strings using said circumscribed
15 rectangles extracted by said circumscribed rectangle
extraction unit;

a distance estimation unit which estimates a distance between said reference plane and said original using said character strings; and

20 an image distortion correction unit which
corrects said distorted image based on said distance
between said reference plane and said original
estimated by said image distortion correction unit.

2. The image distortion correction
apparatus as claimed in claim 1 further comprising:

5 an original distinction unit which decides
whether said original is written horizontally or
vertically, wherein in case that said original
distinction unit decides that said original is
written in the horizontal,

10 said distance estimation unit first,
selects character strings each of which has a length
longer than a length of a predetermined ratio to
that of the longest string out of a plurality of
character strings in said distorted image, then,
15 selects one string having the largest curvature out
of said selected character strings for a reference
character string, and then, estimates a distance
between said reference plane and said original using
said reference string.

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3. The image distortion correction
25 apparatus as claimed in claim 2, wherein said

curvature is measured based on the location of the center coordinates in a main scanning direction of the circumscribed rectangle in the character string, and the larger a difference between a maximum value of said center coordinates and a minimum value of said center coordinates, the larger is the said curvature.

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4. The image distortion correction apparatus as claimed in claim 1 further comprising:
an original distinction unit which decides
15 whether said original is written horizontally or vertically, wherein in case that said original distinction unit decides that said original is written in the vertical,

said character string extraction unit
20 extracts a reference character string using circumscribed rectangles either at a top of or at a bottom of each vertical line,

said distance estimation unit estimates a distance between said reference plane and said
25 original using said reference string.

5 5. The image distortion correction
apparatus as claimed in claim 2, wherein

 said distance estimation unit measures
both a first distance D1 between a prolonged line of
a line part in said reference character string and a
10 curve part in said reference character string and a
second distance D2 between an imaging center line
and said curve part in said reference character
string, and estimates a distance D between said
reference plane and said original based on

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$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
and a center of a lens.

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 6. The image distortion correction
apparatus as claimed in claim 3, wherein

 said distance estimation unit measures
25 both a first distance D1 between a prolonged line of

a line part in said reference character string and a
curve part in said reference character string and a
second distance D2 between an imaging center line
and said curve part in said reference character
5 string, and estimates a distance D between said
reference plane and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
and a center of a lens.

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7. The image distortion correction
apparatus as claimed in claim 4, wherein

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said distance estimation unit measures
both a first distance D1 between a prolonged line of
a line part in said reference character string and a
curve part in said reference character string and a
second distance D2 between an imaging center line
and said curve part in said reference character
string, and estimates a distance D between said
reference plane and said original based on

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$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane and a center of a lens.

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8. The image distortion correction apparatus as claimed in claim 1, wherein

said distance estimation unit

10 independently estimates each distance between said reference plane and said original for a left page and a right page.

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9. An image distortion correction apparatus comprising:

20 a ruled line extraction unit which extracts a ruled lines in a distorted image scanned by an image reading unit to read an original placed on a reference plane;

a distance estimation unit which
25 estimates a distance between said reference plane

and said original using said ruled lines; and

an image distortion correction unit which
corrects said distorted image based on said distance
between said reference plane and said original

5 estimated by said image distortion correction unit.

10 10. The image distortion correction
apparatus as claimed in claim 9 further comprising:

an original distinction unit which decides
whether said original is written horizontally or
vertically, wherein in case that said original
15 distinction unit decides that said original is
written in the horizontal,

said distance estimation unit first,
selects ruled lines each of which has a length
longer than a length of a predetermined ratio to
20 that of the longest ruled line out of a plurality of
ruled lines in said distorted image, then, selects
one ruled line placed nearest an upper edge or a
lower edge of the scanned image out of said selected
ruled lines for a reference ruled line, and then,
25 estimates a distance between said reference plane

and said original using said reference ruled line.

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11. The image distortion correction apparatus as claimed in claim 10, wherein

said distance estimation unit measures both a first distance D1 between a prolonged line of
10 a line part in said reference ruled line and a curve part in said reference ruled line and a second distance D2 between an imaging center line and said curve part in said reference ruled line, and estimates a distance D between said reference plane
15 and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane and a center of a lens.

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12. The image distortion correction apparatus as claimed in claim 9, wherein

25 said distance estimation unit

independently estimates each distance between said reference plane and said original for a left page and a right page.

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13. A computer readable recording media having a program to execute an image distortion
10 correction method, said program comprising steps of:

a circumscribed rectangle extraction step
for extracting a circumscribed rectangle for each
character in a distorted image scanned by an image
reading step to read an original placed on a
15 reference plane;

a character string extraction step for
extracting character strings using said
circumscribed rectangles extracted by said
circumscribed rectangle extraction step;
20 a distance estimation step for estimating
a distance between said reference plane and said
original using said character strings; and

an image distortion correction step for
correcting said distorted image based on said
25 distance between said reference plane and said

original estimated by said image distortion
correction step.

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14. The computer readable recording media
as claimed in claim 13 further comprising:

an original distinction step which decides
10 whether said original is written horizontally or
vertically, wherein in case that said original
distinction step decides that said original is
written in the horizontal,

said distance estimation step first,
15 selects character strings each of which has a length
longer than a length of a predetermined ratio to
that of the longest string out of a plurality of
character strings in said distorted image, then,
selects one string having the largest curvature out
20 of said selected character strings for a reference
character string, and then, estimates a distance
between said reference plane and said original using
said reference string.

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15. The computer readable recording media
as claimed in claim 14, wherein said curvature is
5 measured based on a location of center coordinates
in a main scanning direction of the circumscribed
rectangle in the character string, and the larger a
difference between a maximum value of said center
coordinates and a minimum value of said center
10 coordinates, the larger is the said curvature.

15 16. The computer readable recording media
as claimed in claim 13 further comprising:

an original distinction step for deciding
whether said original is written horizontally or
vertically, wherein in case that said original
20 distinction step decides that said original is
written in the vertical,

said character string extraction step
extracts a reference character string using
circumscribed rectangles either at a top of or at a
25 bottom of each vertical line,

said distance estimation step estimates a distance between said reference plane and said original using said reference string.

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17. The computer readable recording media as claimed in claim 14, wherein

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said distance estimation step measures both a first distance D1 between a prolonged line of a line part in said reference character string and a curve part in said reference character string and a second distance D2 between an imaging center line and said curve part in said reference character string, and estimates a distance D between said reference plane and said original based on

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$$D = R \times (D1 / D2)$$

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, where R is a distance between said reference plane and a center of a lens.

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18. The computer readable recording media

as claimed in claim 15, wherein

said distance estimation step measures
both a first distance D1 between a prolonged line of
a line part in said reference character string and a
5 curve part in said reference character string and a
second distance D2 between an imaging center line
and said curve part in said reference character
string, and estimates a distance D between said
reference plane and said original based on

10
$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
and a center of a lens.

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19. The computer readable recording media
as claimed in claim 16, wherein

20 said distance estimation step measures
both a first distance D1 between a prolonged line of
a line part in said reference character string and a
curve part in said reference character string and a
second distance D2 between an imaging center line
25 and said curve part in said reference character

string, and estimates a distance D between said
reference plane and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
5 and a center of a lens.

10 20. The computer readable recording media
as claimed in claim 13, wherein
said distance estimation step
independently estimates each distance between said
reference plane and said original for a left page
15 and a right page.

20 21. A computer readable recording media
having a program to execute an image distortion
correction method, said program comprising steps of:
a ruled line extraction step for
25 extracting ruled lines in a distorted image scanned

by an image reading step to read an original placed
on a reference plane;

a distance estimation step for estimating
a distance between said reference plane and said
5 original using said ruled lines; and

an image distortion correction step for
correcting said distorted image based on said
distance between said reference plane and said
original estimated by said image distortion
10 correction step.

15 22. The computer readable recording media
as claimed in claim 21 further comprising:

an original distinction step for deciding
whether said original is written horizontally or
vertically, wherein in case that said original
20 distinction step decides that said original is
written in the horizontal,

said distance estimation step first,
selects ruled lines each of which has a length
longer than a length of a predetermined ratio to
25 that of the longest ruled line out of a plurality of

ruled lines in said distorted image, then, selects
one ruled line placed nearest an upper edge or a
lower edge of the scanned image out of said selected
ruled lines for a reference ruled line, and then,
5 estimates a distance between said reference plane
and said original using said reference ruled line.

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23. The computer readable recording media
as claimed in claim 22, wherein

said distance estimation step measures
both a first distance D1 between a prolonged line of
15 a line part in said reference ruled line and a curve
part in said reference ruled line and a second
distance D2 between an imaging center line and said
curve part in said reference ruled line, and
estimates a distance D between said reference plane
20 and said original based on

$$D = R \times (D1 / D2)$$

, where R is a distance between said reference plane
and a center of a lens.

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24. The computer readable recording media
as claimed in claim 21, wherein

5 said distance estimation step
independently estimates each distance between said
reference plane and said original for a left page
and a right page.

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25. An image distortion correction
method comprising steps of:

15 a circumscribed rectangle extraction step
for extracting a circumscribed rectangle for each
character in a distorted image scanned by an image
reading step to read an original placed on a
reference plane;

20 a character string extraction step for
extracting character strings using said
circumscribed rectangles extracted by said
circumscribed rectangle extraction step;

 a distance estimation step for estimating
25 a distance between said reference plane and said

original using said character strings; and

an image distortion correction step for
correcting said distorted image based on said
distance between said reference plane and said
5 original estimated by said image distortion
correction step.

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26. An image distortion correction method
comprising steps of:

a ruled line extraction step for
extracting ruled lines in a distorted image scanned
15 by an image reading unit to read an original placed
on a reference plane;

a distance estimation step for estimating
a distance between said reference plane and said
original using said ruled lines; and

20 an image distortion correction step for
correcting said distorted image based on said
distance between said reference plane and said
original estimated by said image distortion
correction step.

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27. An image scanner comprising:

5 an image reading unit to read an original
placed on a reference plane; and

 an image distortion correction apparatus
comprising;

 a circumscribed rectangle extraction unit
10 which extracts a circumscribed rectangle for each
character in a distorted image scanned by said image
reading unit;

 a character string extraction unit which
extracts character strings using said circumscribed
15 rectangles extracted by said circumscribed rectangle
extraction unit;

 a distance estimation unit which estimates
a distance between said reference plane and said
original using said character strings; and

20 an image distortion correction unit which
corrects said distorted image based on said distance
between said reference plane and said original
estimated by said image distortion correction unit.

28. An image scanner comprising:

an image reading unit to read an original
5 placed on a reference plane; and

an image distortion correction apparatus
comprising;

a ruled line extraction unit which
extracts ruled lines in a distorted image scanned by
10 said image reading unit;

a distance estimation unit which estimates
a distance between said reference plane and said
original using said ruled lines; and

an image distortion correction unit which
15 corrects said distorted image based on said distance
between said reference plane and said original
estimated by said image distortion correction unit.

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29. An image forming apparatus

comprising:

an image reading unit to read an original
25 placed on a reference plane;

an image distortion correction apparatus
comprising;

a circumscribed rectangle extraction unit
which extracts a circumscribed rectangle for each
5 character in a distorted image scanned by said image
reading unit;

a character string extraction unit which
extracts character strings using said circumscribed
rectangles extracted by said circumscribed rectangle
10 extraction unit;

a distance estimation unit which estimates
a distance between said reference plane and said
original using said character strings; and

an image distortion correction unit which
15 corrects said distorted image based on said distance
between said reference plane and said original
estimated by said image distortion correction unit;
and,

a printing unit which prints said
20 corrected image supplied from said image distortion
correction apparatus on a paper.

30. An image forming apparatus

comprising:

an image reading unit to read an original
placed on a reference plane;

5 an image distortion correction apparatus
comprising;

a ruled line extraction unit which
extracts ruled lines in a distorted image scanned by
said image reading unit;

10 a distance estimation unit which estimates
a distance between said reference plane and said
original using said ruled lines; and

an image distortion correction unit which
corrects said distorted image based on said distance
15 between said reference plane and said original
estimated by said image distortion correction unit;
and

a printing unit which prints said
corrected image supplied from said image distortion
20 correction apparatus on a paper.